

Introduction

- Insects are widely used in research, in the food industry, and in art, entertainment and fashion. Another recent use of insects involves integrating living organisms with robotic systems to create cyborg insects (e.g. Bozkurt et al., 2009; Sato et al., 2009; Sanchez et al., 2015).
- Cyborg insects are proposed to be useful in military contexts such as surveillance and the detection of explosives (Dodd, 2014), for search and rescue operations (Sanchez et al., 2015), and as educational aids (Backyard Brains, 2016).
- There are a number of different stakeholders in the use of cyborg insects. The U.S. Department of Defence, for example, are funding development of hybrid insect systems (Dodd, 2014), whilst there are mixed reactions to the use of cyborg insects within the scientific community. These range from ethical concerns to doubts on the feasibility of proposed uses, to a recognition of potential benefits (BBC News, 2006; Grémillet et al., 2012; Dodd, 2014).
- Another important consideration is public acceptance of their use. A number of different factors are likely to impact on this including the insect species utilised, perceptions of whether insects experience pain, and the proposed context in which the cyborg insects are to be used.

Insect Species Used

- A number of the key taxa currently used as cyborg insects, such as cockroaches (Sanchez et al., 2015; Backyard Brains, 2016), and moths (Bozkurt et al., 2009; Tsang et al., 2010) are perceived by the public as pest species and associated with disease, dirt and damage (Kellert, 1993; Horvath et al., 2013).
- Since the public generally view cockroaches and moths as expendable pest species (Rentokil, 2016a,b) with little value, they may be likely to display little concern regarding the use of these insects. The use of species commonly perceived as pests when developing cyborg insects may be proposed to be beneficial in encouraging public acceptance, or at least not provoking rejection of their use.

Perceptions of Whether Insects Experience Pain

- Whether insects feel pain is a much-debated topic in the field of animal welfare (e.g. Eisemann et al., 1984; Adamo, 2016).
- Systematic study of the public’s opinion regarding whether insects experience pain has not been performed. However, the limited exploration undertaken by Kellert (1993) suggested that the public sampled believed that insects could experience pain.
- Public concern regarding the pain experiences of insects are also supported by the Ofcom complaints received when live insects were crushed and/or eaten in popular TV shows such as “I’m a celebrity get me out of here!” (Digital Spy, 2003).

Proposed Context of Use

- Whilst the public perception of the use of cyborg insects has not been systematically studied, some understanding of public opinion can be gathered by considering news reports. This is as news reports in the media can both reflect and influence public opinion (e.g. McCombs, 2002; Patterson, 2008).
- The media portrayal of the use of cyborg insects varies depending on their context of use (Table 1).

Context of Use	Media Portrayal	Suggested Explanation for Media Portrayal	Examples
Search and Rescue	Positive	Utilitarian considerations regarding benefits to human disaster victims who could be saved by their use outweighing costs to insects.	“Roaches to the rescue” (The Economist, 2012); “Bionic bugs could be sent to disaster zones to seek out humans trapped under rubble” (Daily Mail, 2014); “How cyborg cockroaches could save the lives of disaster victims” (The Mirror, 2014).
Military Context- Explosive detection	Positive	Utilitarian considerations as the benefits of saving human lives via detecting explosives or thwarting terrorist attacks are clear, whilst public surveillance is generally viewed with more distrust and has less readily apparent benefits.	“Could cyborg insects sniff out bombs?” (Daily Mail, 2016); “Cyborg locusts being developed to sniff out explosives” (ITV News, 2016); “Engineers develop cyborg locusts to sniff out explosives” (The Telegraph, 2016).
Military Context- Information gathering	Mixed		“Remote controlled 'cyborg beetles' could be used to spy on terrorists” (The Mirror, 2016); “Is that really just a fly? Swarms of cyborg insect drones are the future of military surveillance” (Daily Mail, 2012).
Educational Aids, e.g. RoboRoach (Backyard Brains, 2016)	Negative	Criticisms relate to three main explanations: 1) The belief that cruelty/lack of respect is being displayed 2) Lack of belief in the proposed educational function (Utilitarian considerations) 3) Impact on children performing these procedures (e.g. Graduation Hypothesis).	“...encouraged people to think of the insects as mere machines or tools” (The Independent, 2013); “...no way a child is going to learn anything about neurological diseases or be interested in studying it in the future based on mutilating a cockroach” (Time Magazine, 2013); “the backpack - known as Roboroach- "teaches kids to be psychopaths” (BBC News, 2013).

Table 1: Consideration of media portrayal of cyborg insects in search and rescue, military and educational contexts.

Conclusions

- The popularity and charisma of the insect species used, belief in insects’ capacity to experience pain, and the perceived benefits of their use in particular contexts are all likely to impact on whether cyborg insects are perceived as an acceptable use or unacceptable abuse of insects.
- Further systematic study of these factors upon public opinion and/or acceptance of cyborg insects will be valuable in elucidating this field of study.

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